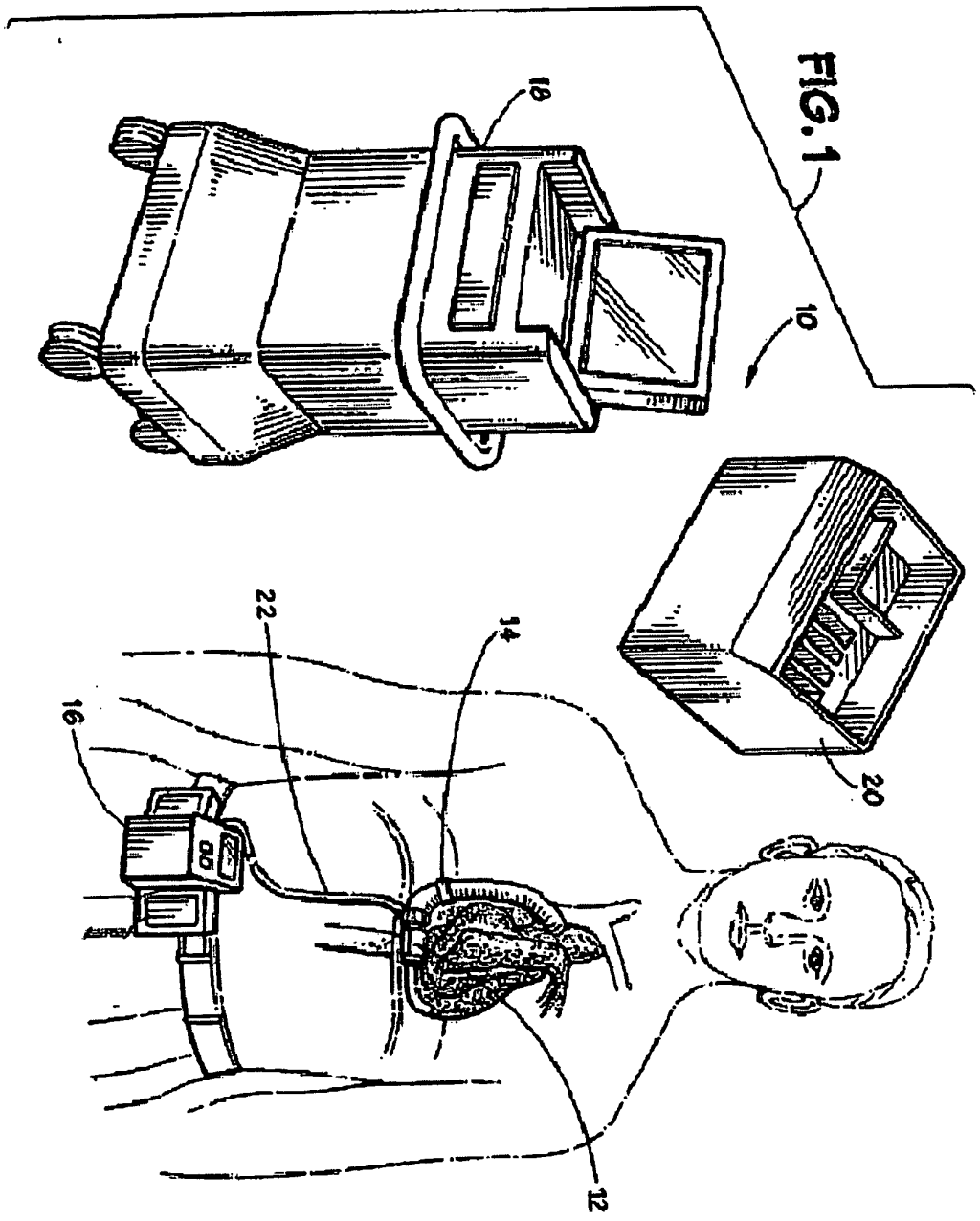

FIG. 1

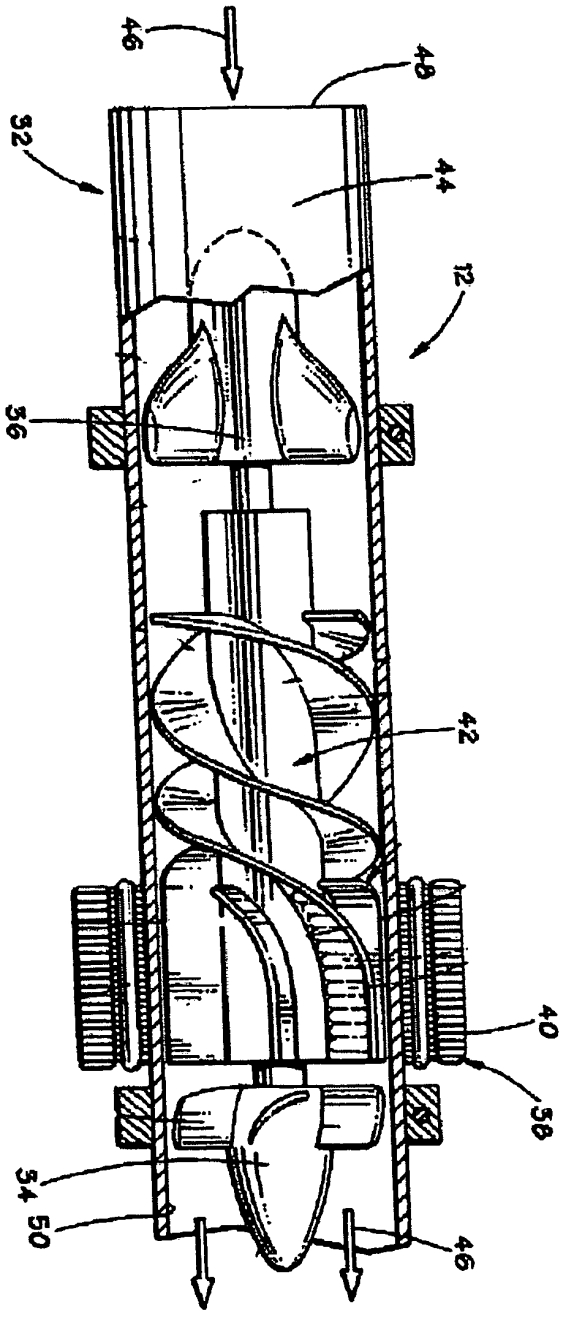

FIG. 2

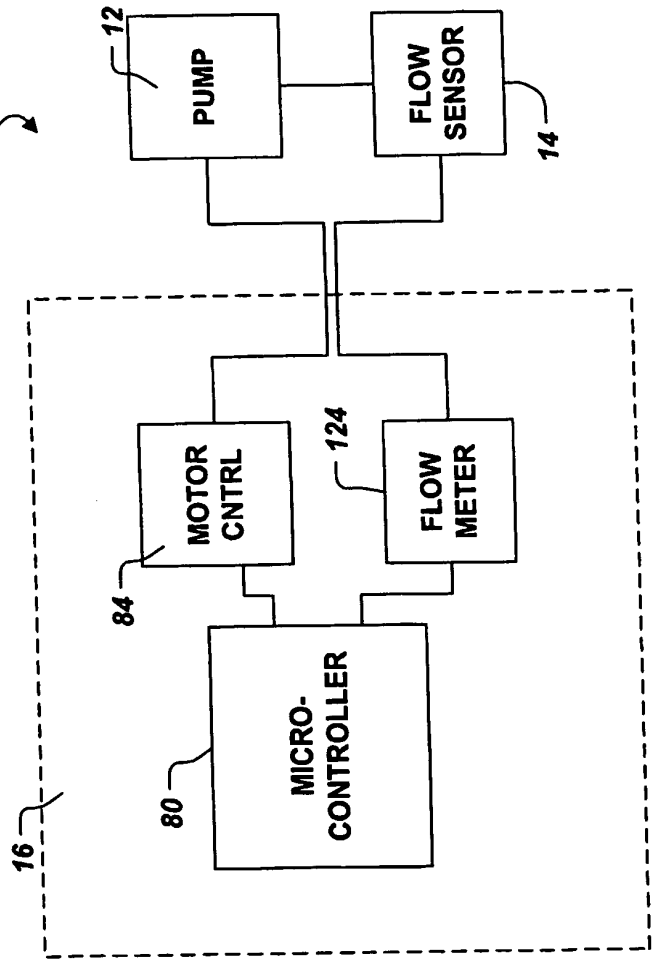
10
12
PUMP
FLOW SENSOR
14
MOTOR CNTRL
84
124
FLOW METER
MICRO-CONTROLLER
80
16

FIG. 3

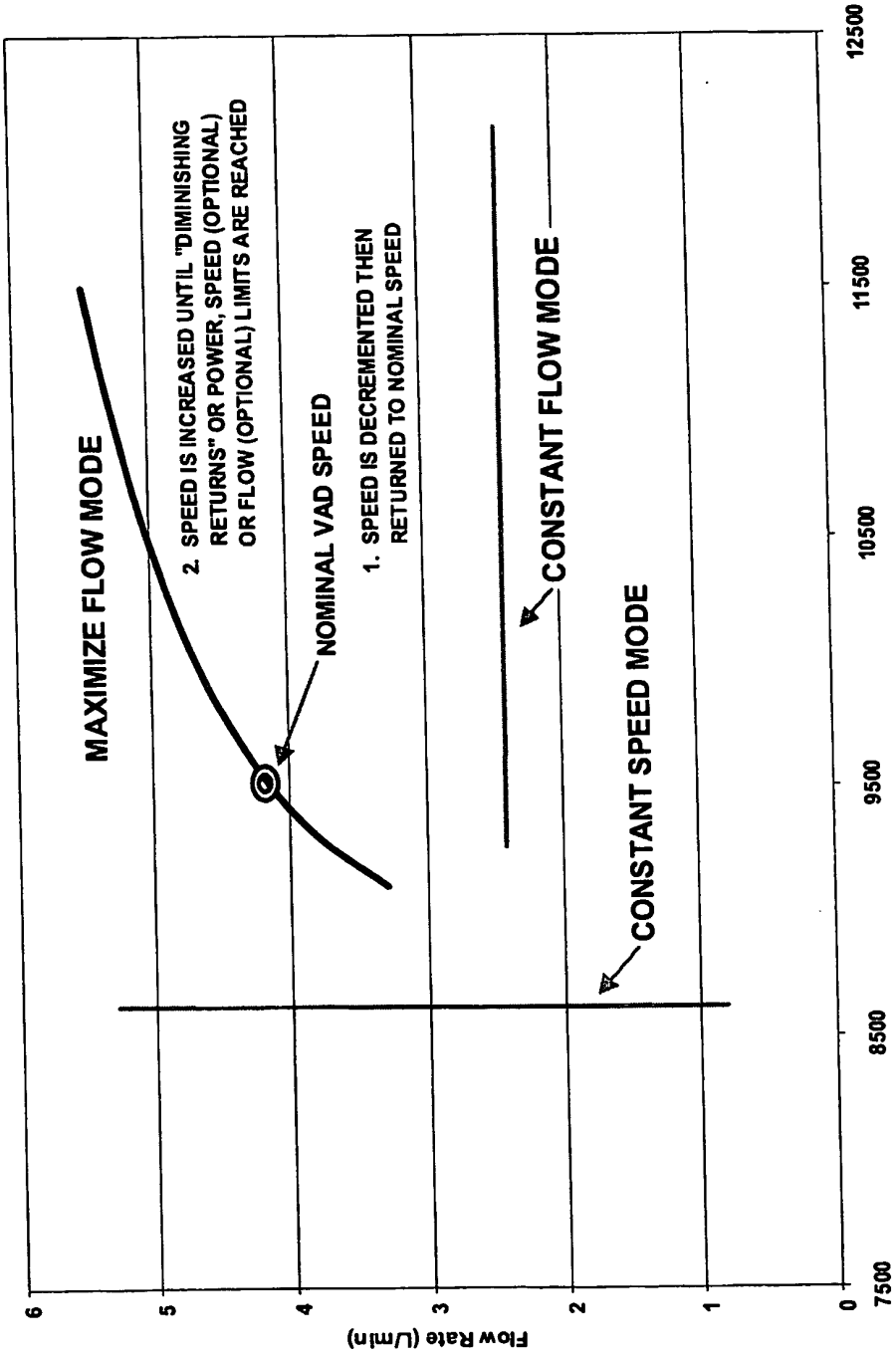
MAXIMIZE FLOW MODE
2. SPEED IS INCREASED UNTIL "DIMINISHING RETURNS" OR POWER, SPEED (OPTIONAL) OR FLOW (OPTIONAL) LIMITS ARE REACHED
NOMINAL VAD SPEED
1. SPEED IS DECREMENTED THEN RETURNED TO NOMINAL SPEED
CONSTANT FLOW MODE
CONSTANT SPEED MODE
Flow Rate (L/min)
Speed (RPM)
0
1
2
3
4
5
6
7500
8500
9500
10500
11500
12500

FIG. 4A

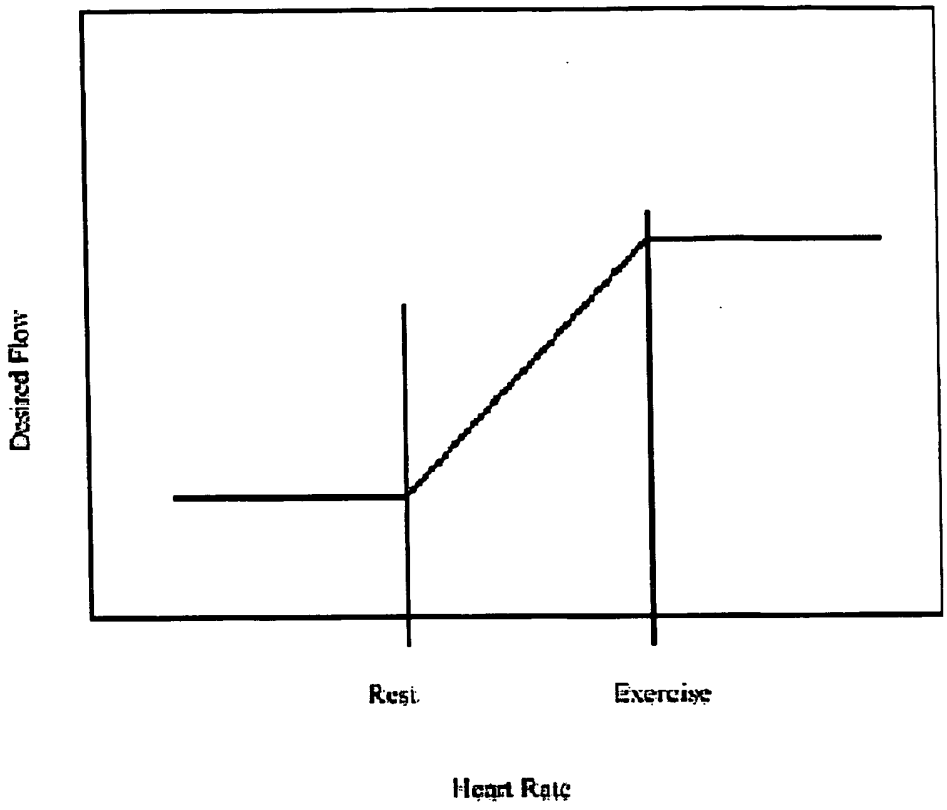

FIG. 4B

FIG. 5A. Constant Speed

Control	Speed limit/alarm		Power	Flow		Suction	Suction Detection
Variable	Min	Max	Max	Min	Max	Detection	Response
enter Speed	7.5k	n/a	15W	**enter min**	n/a	Enabled/Disabled	Enabled/Disabled

FIG. 5B Nominal Flow

Control	Speed limit/alarm		Power	Flow		Suction	Suction Detection
Variable	Min	Max	Max	Min	Max	Detection	Response
enter Flow	8.0k	11.0k	8+Flow * 1.5	Flow * .75	n/a	Enabled	Enabled

FIG. 5C. Constant waviness

Control	Speed limit/alarm		Power	Flow		Suction	Suction Detection
Variable	Min	Max	Max	Min	Max	Detection	Response
P2P = 4	8.0k	11.0k	8+Flow * 1.5	**enter min**	n/a	Enabled	Enabled

FIG. 5D Maximize Flow - waviness (P2P)

Control	Speed limit/alarm		Power	Flow		Suction	Allow Flow
Variable	Min	Max	Max	Min	Max	Detection/Response	Below Baseline**
P2P = 2***	9.0k	12.0k	18	imported	n/a	Enabled/Enabled	Enabled/Disabled

FIG. 5E Maximize Flow - dQ/dN (diminishing returns)

Control	Speed limit/alarm		Power	Flow		Suction	Allow Flow
Variable	Min	Max	Max	Min	Max	Detection/Response	Below Baseline**
dQ/dN	9.0k	12.0k	18	imported	n/a	Enabled/Enabled	Enabled/Disabled

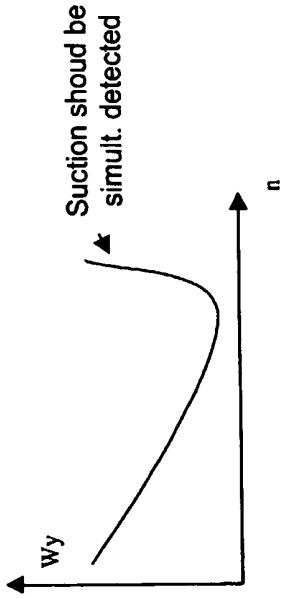

FIG. 6A

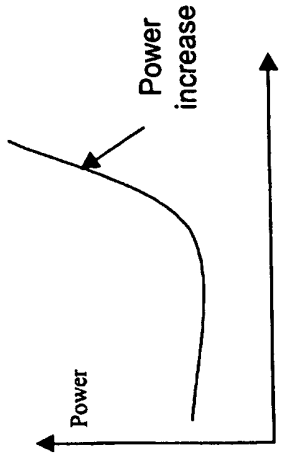

FIG. 6B

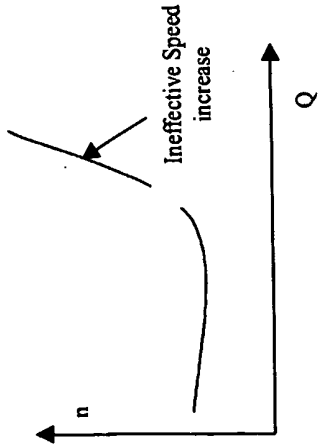

FIG. 6C

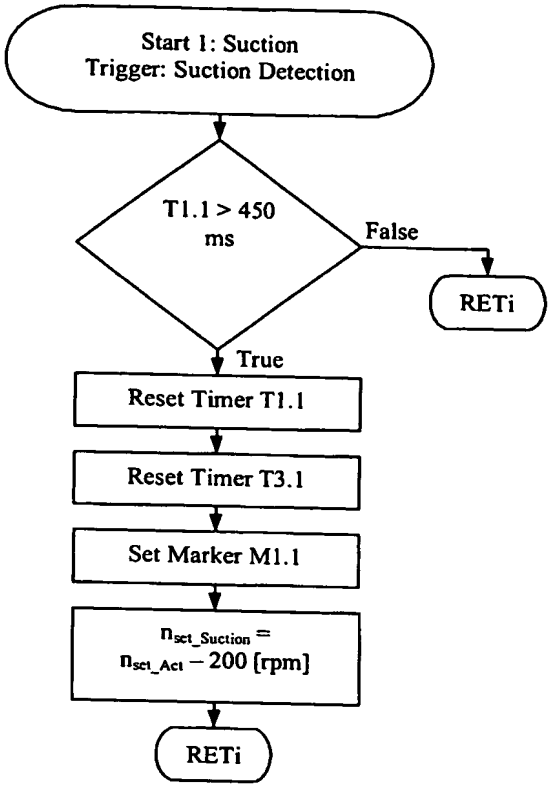
Start 1: Suction
Trigger: Suction Detection
T1.1 > 450 ms
False
RETi
True
Reset Timer T1.1
Reset Timer T3.1
Set Marker M1.1
$n_{set_Suction} = n_{set_Act} - 200$ [rpm]
RETi

FIG. 7

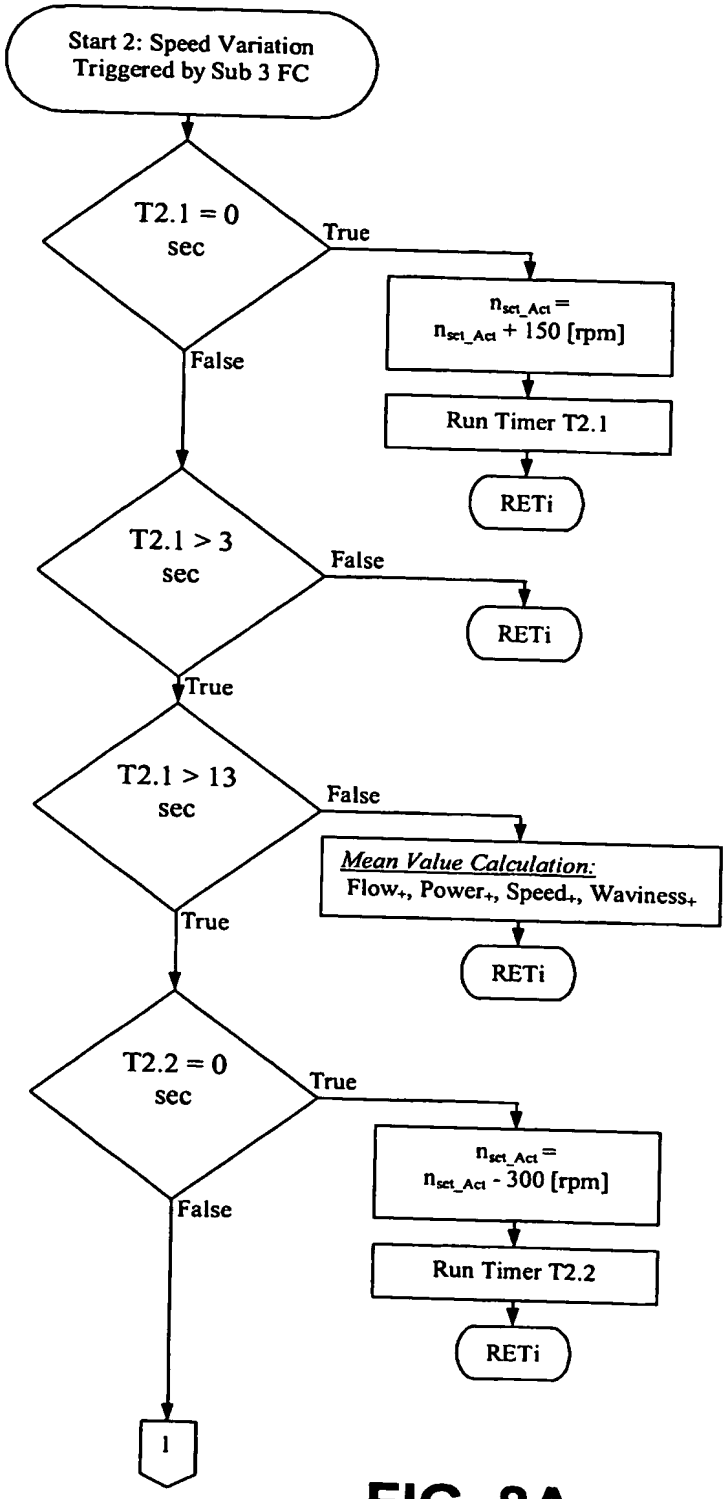
Start 2: Speed Variation Triggered by Sub 3 FC
T2.1 = 0 sec
True
n_{set_Act} = n_{set_Act} + 150 [rpm]
Run Timer T2.1
RETi
False
T2.1 > 3 sec
False
RETi
True
T2.1 > 13 sec
False
Mean Value Calculation:
Flow+, Power+, Speed+, Waviness+
RETi
True
T2.2 = 0 sec
True
n_{set_Act} = n_{set_Act} - 300 [rpm]
Run Timer T2.2
RETi
False
1

FIG. 8A

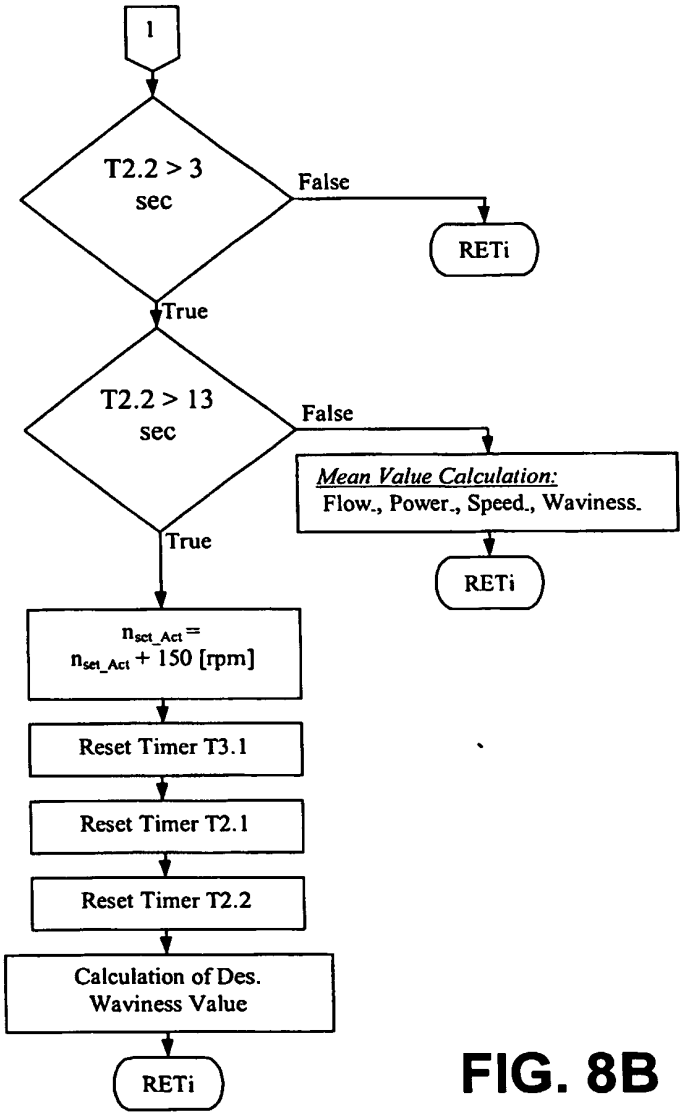
1
T2.2 > 3 sec
False
RETi
True
T2.2 > 13 sec
False
Mean Value Calculation:
Flow., Power., Speed., Waviness.
RETi
True
n_{sct_Act} = n_{set_Act} + 150 [rpm]
Reset Timer T3.1
Reset Timer T2.1
Reset Timer T2.2
Calculation of Des. Waviness Value
RETi

FIG. 8B

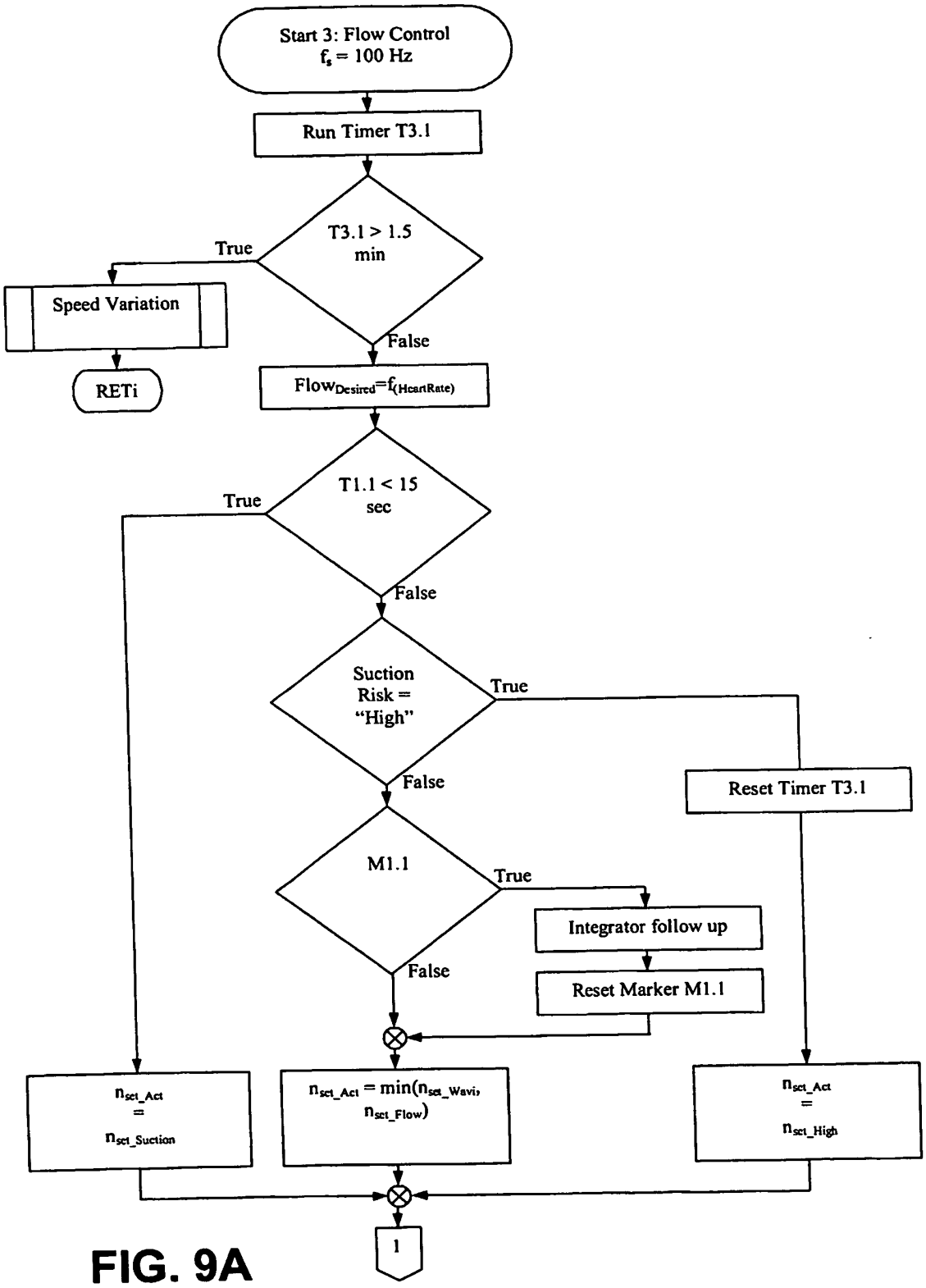
Start 3: Flow Control
f_s = 100 Hz
Run Timer T3.1
T3.1 > 1.5 min
True
Speed Variation
RETi
False
$Flow_{Desired}=f_{(HeartRate)}$
T1.1 < 15 sec
True
False
Suction Risk = "High"
True
False
Reset Timer T3.1
M1.1
True
Integrator follow up
Reset Marker M1.1
False
n_{set_Act} = $n_{set_Suction}$
$n_{set_Act} = min(n_{set_Wavi}, n_{set_Flow})$
n_{set_Act} = n_{set_High}
1

FIG. 9A

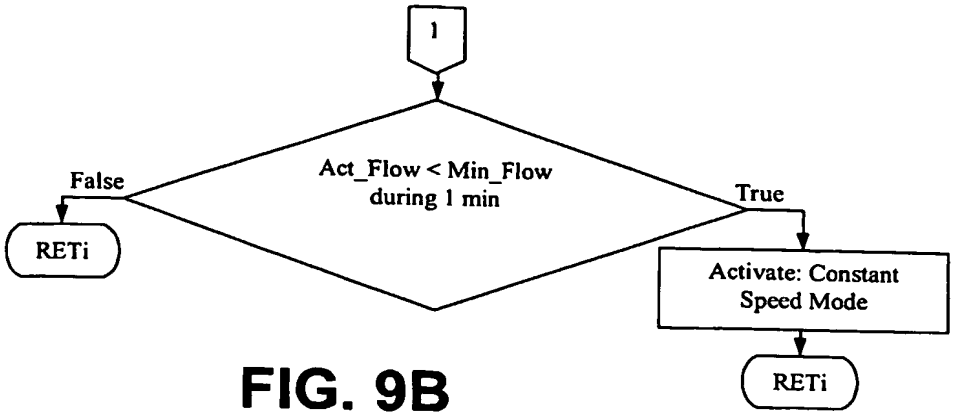

FIG. 9B

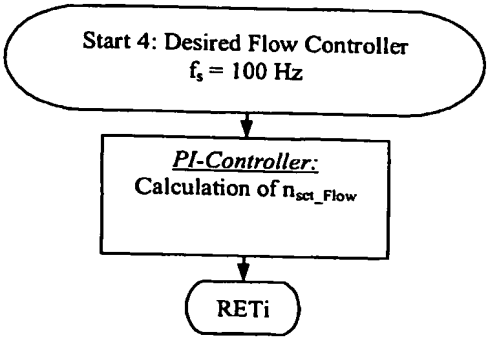

FIG. 10

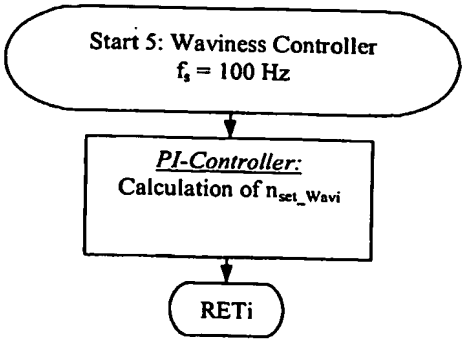

FIG. 11

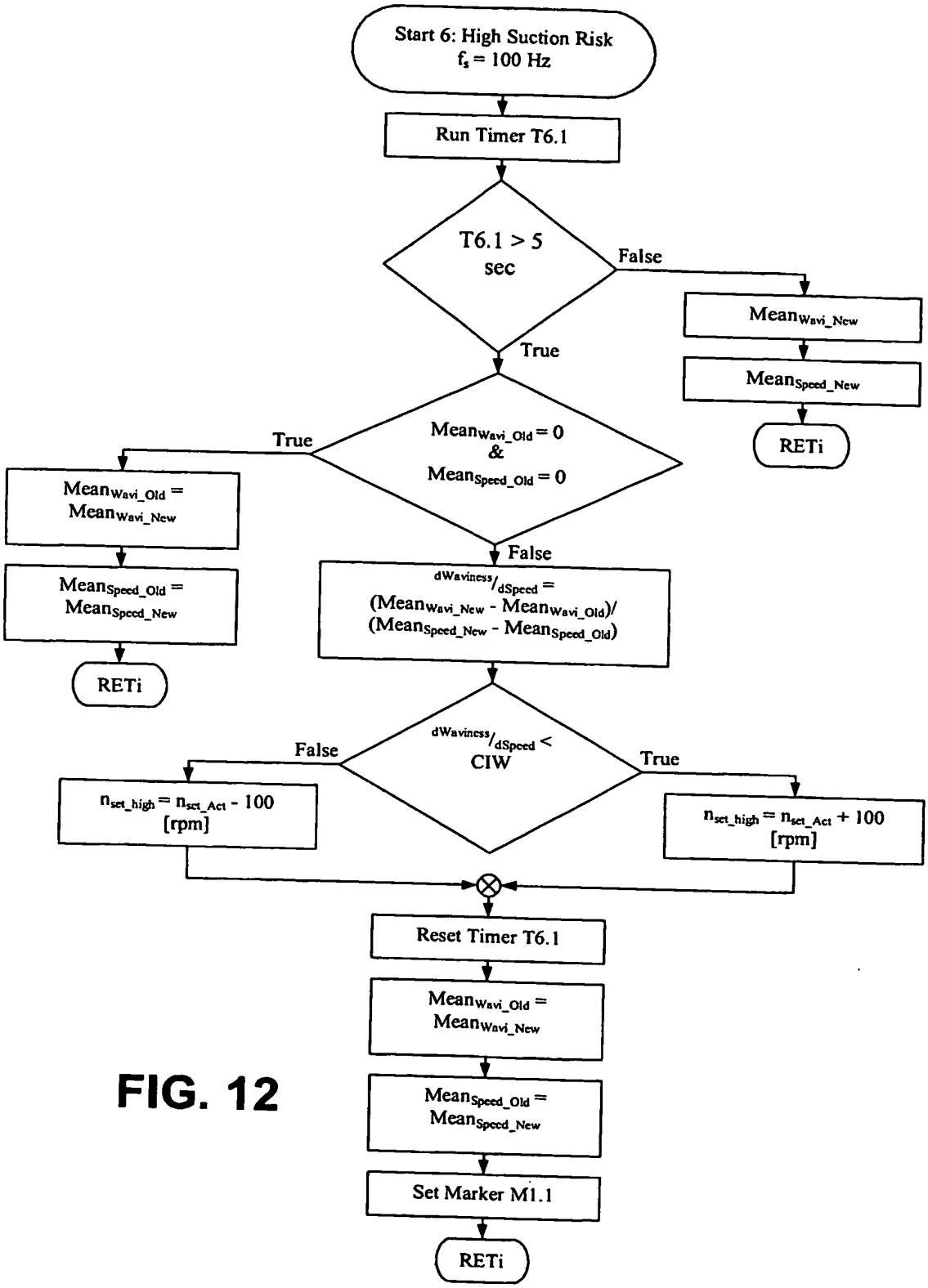
Start 6: High Suction Risk
f_s = 100 Hz
Run Timer T6.1
T6.1 > 5 sec
False
True
$Mean_{Wavi_New}$
$Mean_{Speed_New}$
RETi
$Mean_{Wavi_Old}$ = 0 & $Mean_{Speed_Old}$ = 0
True
False
$Mean_{Wavi_Old}$ = $Mean_{Wavi_New}$
$Mean_{Speed_Old}$ = $Mean_{Speed_New}$
RETi
$^{dWaviness}/_{dSpeed}$ = ($Mean_{Wavi_New}$ - $Mean_{Wavi_Old}$)/ ($Mean_{Speed_New}$ - $Mean_{Speed_Old}$)
$^{dWaviness}/_{dSpeed}$ < CIW
False
True
n_{set_high} = n_{set_Act} - 100 [rpm]
n_{set_high} = n_{set_Act} + 100 [rpm]
Reset Timer T6.1
$Mean_{Wavi_Old}$ = $Mean_{Wavi_New}$
$Mean_{Speed_Old}$ = $Mean_{Speed_New}$
Set Marker M1.1
RETi

FIG. 12

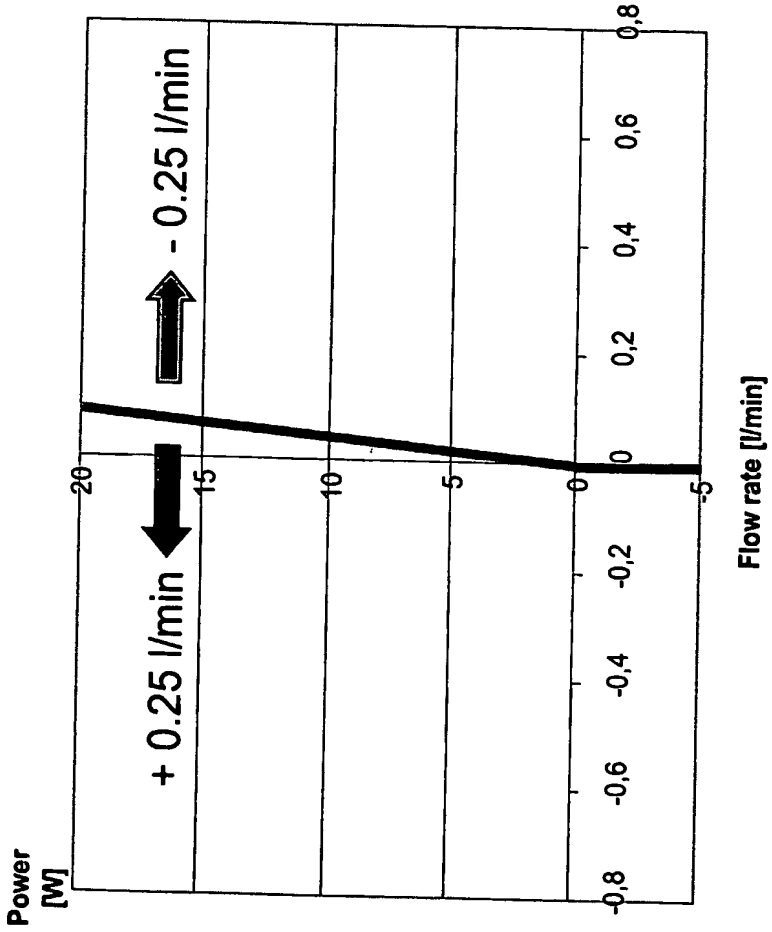
- 0.25 l/min
+ 0.25 l/min
Power [W]
20
15
10
5
0
-5
0,8
0,6
0,4
0,2
0
-0,2
-0,4
-0,6
-0,8
Flow rate [l/min]

FIG. 13